Note on Errors When Determining Two Parameters

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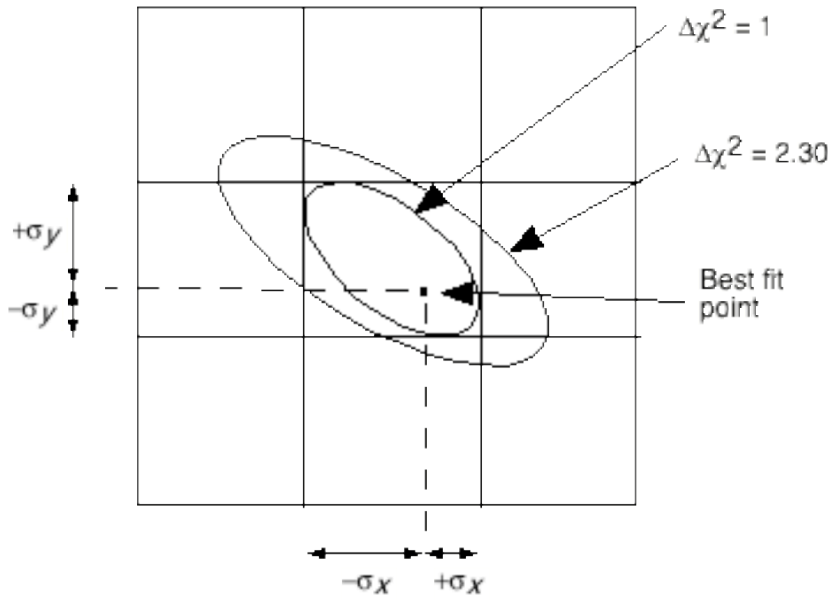
The question I am addressing is how one quotes uncertainties on measurements x and y [in our case Δm^2 and $\sin^2(2\theta)$] when making a joint measurement of them. I found the discussion in the PDG writeup incomprehensible, so I made a quick call to Bob Cousins, and he explained it to me.

The technique being used is a Gaussian approximation to the full frequentist treatment. In this technique, one finds the best-fit point in the two-dimensional x-y space and calculates contours of constant $\Delta\chi^2$ from this point. In the drawing below, two such contours are shown. The outer contour corresponds to $\Delta\chi^2 = 2.30$ and, in this approximation, it has a probability of 68.27% (1σ) that the true values of both x and y will be found within it.

The inner contour corresponds to $\Delta\chi^2 = 1$. Vertical and horizontal strips are constructed by drawing them from the horizontal and vertical tangents of this inner contour. These strips each also have a probability of 68.27% that the true value of both x and y are within them. It is thus the distance from the best fit point to the edges of these strips that one wants to quote as the 1σ errors on the individual measurements of x and y.



MINUIT does all of this correctly, so the errors that people have been quoting based on the MINUIT values are in fact correct.

I apologize to all those in the collaboration who understood all of this, but I suspect that there were at least a few, including me, who didn't.